CITY COUNCIL OF THE CITY OF ANNAPOLIS

RESOLUTION NO. R-20-04

Introduced by Mayor Moyer

A RESOLUTION concerning

Natural Hazard Mitigation Plan

FOR the purpose of approving the City of Annapolis Natural Hazard Mitigation Plan; and matters generally relating to said plan. .

WHEREAS, the City of Annapolis has developed the Natural Hazard Mitigation Plan in order to reduce risks from natural hazards and to serve as a guide for decisionmakers as they commit resources to reducing the risks from natural hazards, and

WHEREAS, 44 CFR 201.6 requires that local governments must have a mitigation plan formally approved by the governing body of the jurisdiction requesting approval of the plan (e.g. City Council...) in order to be eligible for Hazard Mitigation Grants Program (HMGP) project grants for disasters declared after November 1, 2003.

NOW THEREFORE BE IT RESOLVED BY THE ANNAPOLIS CITY COUNCIL that the attached Natural Hazard Mitigation Plan is hereby approved.

ADOPTED this 25th day of October, 2004.

ATTEST: **THE ANNAPOLIS CITY COUNCIL**

BY: _____

Deborah Heinbuch, MMC **ELLEN O. MOYER, MAYOR**
City Clerk

ANNAPOLIS, MARYLAND

NATURAL HAZARD MITIGATION PLAN

October 2004

The information and conclusions contained in this report are intended for use by government officials in emergency preparedness and mitigation planning activities only. They should not be applied in any other context or for any other purpose. They are not intended for use by non-government entities. Anyone seeking to use the information contained in this report is advised to contact the City of Annapolis Department of Emergency Services beforehand for guidance and technical assistance.

This report was prepared by:
Capuco Consulting Services, Inc.

Attachment to R-20-04
As amended

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1.0 Introduction

To support better mitigation planning in order to prepare for and minimize the impacts of disasters in the future, Congress enacted the Disaster Mitigation Act of 2000 (DMA 2000). In 2002, the Federal Emergency Management Agency (FEMA) issued regulations to implement requirements for mitigation planning by states and communities. FEMA is the lead agency supporting implementation of the DMA 2000 requirements and will make funds available to support efforts to meet these requirements.

To be eligible for FEMA funds, state and local entities are required to prepare DMA 2000 Hazard Mitigation Plans for natural hazards.

The purpose of this plan is to assess the communities' vulnerabilities to natural hazards and prepare a long-term strategy to address these hazards and prevent future damage and loss of life of Annapolis City residents. This document was the outcome of participation from State, County and municipal officials, residents, business owners, and other agencies.

2.0 Overview

As characterized by the Annapolis *Hazard Identification and Risk Assessment* of 2002, The City of Annapolis is located in Anne Arundel County, MD on a peninsula between two tributaries of the Chesapeake Bay, the Severn and South Rivers. Historically, Annapolis functioned as a port city, state capital, and freestanding center for a predominantly agricultural region. In recent decades, the City has been increasingly affected by its location within the commuter sheds of the metropolitan areas of Baltimore to the north and Washington, DC to the west. Because of this location, increasing numbers of residents choose to live in Annapolis or the adjacent County and commute to jobs in the Baltimore or Washington region. Completion of a series of highway improvements in recent years, including widening of US Route 50/301 and construction of Interstate 97 and Aris T. Allen Boulevard 665, have reduced travel times to these metropolitan areas and helped spur development in Anne Arundel County. With the exception of relatively recently annexed areas along Forest Drive, the City has experienced less development than the County because of the lack of vacant land.

The geographic context of Annapolis can best be characterized as a cul-de-sac, due to the City's location on a peninsula surrounded on three sides by water. Rowe Boulevard and other local arterials provide access to the regional highway system to the northwest of the City, which converges at Parole.

2.1 Population Demographics

The City's population was estimated at 35,838 in 2000, an increase of 11.5 percent from the 1980 population of 31,740. Since much of the City is developed, the population of Annapolis is projected to continue growing at a modest pace for the foreseeable future. In addition, the City derives significant economic benefit from a healthy tourism industry, the state capital, and the presence of two colleges within the city limits. On certain days during any year, the city's population may swell by an additional 10 – 50,000 people.

The City's demographics indicate that the City is widely diverse in many aspects. Based on the 2000 Census, the City's population has a median age of 35.7 years old. The population is approximately 62% Caucasian and 38% identified themselves as minorities. The largest minority groups include African Americans at 30% and Latinos at 6%. It is conceivable that an unmeasured number of undocumented individuals reside in Annapolis, a population that receives

city services and benefits from infrastructure, but may not be accounted for in quantitative analyses presented in section 7 of this plan.

2.2 Housing Demographics

The 2000 Census determined that there are 16,000 housing units in the City. Approximately 95% of the housing units were occupied at the time of the Census. Annapolis enjoys a low vacancy rate of homeowner units of 1.4% and rental units of 3.8%. Fifty-two (52%) of the housing stock is owner occupied and 48% is rental occupied. One of the unique features of Annapolis that will play an important role in the education of the public on loss prevention is the location of a substantial number of public housing units within the city limits. Further, to support the tourism and secondary learning industries described above, Annapolis has several pockets of large hotel space and student dormitories. Both of these housing features will also need to be addressed in mitigation plans.

2.3 Economic Demographics

The City of Annapolis income profile, from the 2000 Census (in 1999 dollars) is as follows

Median Income of Households:	$49,243
Median Income of Families:	$56,984
Per capita income:	$27,180
Median earnings of full-time, year-round workers (male):	$39,548
Median earnings of full-time, year-round workers (female):	$30,741

The City of Annapolis poverty profile, from the 2000 Census, shows the following population as being below the poverty level:

All Ages:	12.7%
65 years and over:	10.4%
Related children under 18 years	20.8%
Percent of families:	9.5%

2.4 Critical Facilities and Other Essential Services within Annapolis City Limits.

The city provides essential services such as water, fire and police to its residents. Much of this is conducted in close coordination with Anne Arundel County.

Public utilities serving Annapolis include water, sanitary sewer, storm water drainage, and solid waste. The City manages these utilities with exception of the wastewater treatment facility, which is the responsibility of Anne Arundel County Department of Public Works.

Annapolis is served by a municipal police force consisting of 124 sworn officers and 30 civilian personnel. The City is divided into seven areas for patrol by car and downtown Annapolis is divided into areas for foot patrol. The Fire Department is served by a municipal fire and rescue force of approximately 98 firefighters and 5 civilian personnel that provide fire and disaster protection, emergency health care, rescue, and related services for the City of Annapolis as well as adjacent parts of Anne Arundel County.

3.0 How This Plan Was Developed

In compliance with DMA 2000 requirements, public participation was sought and encouraged throughout the mitigation planning process.

3.1 Planning Committee Formation

A Hazard Mitigation Planning Committee was formed that was comprised of various city staff, county and state staff, and representatives from the US Naval Academy. A series of regular Committee meetings resulted in the development of a coordinated effort by the City, County and State. Below is a list of the participants in the planning committee:

- Annapolis Fire Department
- Anne Arundel County Police
- Annapolis Planning and Zoning Department
- Annapolis Department of Neighborhood & Environmental Programs
- Annapolis Police Department
- Federal Emergency Management Agency
- Maryland Emergency Management Agency
- Maryland Department of the Environment
- Capuco Consulting Services, Inc.
- Tetra-Tech Environmental Management Inc.
- Annapolis Office of Emergency Management

Several members of this committee were also involved in the development of the City's "Hazard Identification and Risk Assessment for Natural Hazards," thus ensuring minimum duplication of effort, and proper incorporation of that document into this plan.

The Committee was actively involved in identifying and discussing assets and hazards within the City, discussion and debate were held on the City's vulnerabilities to natural hazards, and recommendations generated on how to reduce and prevent potential damage from these hazards. Concurrently with the development of the City plan, the county and state were developing their plans. Outlines and drafts were shared to ensure compatibility between the plans.

3.2 Public Involvement

The public involvement elements of this planning process were addressed through a series of working sessions, public hearings, and review and comment periods. The first such session was a working session with members of the Annapolis City Council and the Mayor. During that session, the plan outline was reviewed and the public involvement process discussed and finalized.

The first public meeting was held July 1, 2004 during a regularly scheduled Planning Commission meeting. The plan was publicized as an agenda item in the public notice of the meeting on the city web site and in the local newspaper. The Commission provided comments on the outline and requested additional information to be available at the public hearing.

The second public hearing was held July 15, 2004 during a regularly scheduled planning commission meeting. Again, public notice of the hearing was provided through the usual avenues for this commission. During the July 15 hearing, the mitigation plan goals were reviewed and comment sought on those goals.

A public comment period on the draft plan was held during August 2004 whereby the plan was posted on the city web site and the library held copies for review. In addition, draft plans were sent to community organizations in August for their review. Based on comments received during that public comment period (to be inserted).

The draft plan was then introduced to the public and City Council at a Council meeting on September 13, 2004. A final public hearing was held on September 27, 2004 during the regularly scheduled City Council meeting, and the plan was adopted by the City Council on October 11, 2004. The draft plan was submitted to the State in November 2004.

3.3 Agency Review

The Maryland Emergency Management Agency will serve as the State review agency and clearing house. The following agencies will also receive a draft of the plan for review and comment once the City has adopted the Plan.

- Federal Emergency Management Agency (FEMA), Region III
- Maryland Department of Natural Resources
- Maryland Department of the Environment (MDE)

4.0 Hazard Identification

Hazards are characterized as natural hazards and man-made risks. This document was intentionally restricted to the assessment of natural hazards. The risk assessment for man-made hazards can be found in a separate document

The City of Annapolis is at risk from a broad range of natural hazards. Below is a list of natural and technological hazards that are known to threaten the United States. Those that are in **bold** are those that may occur in or near the City of Annapolis as identified by the City *Hazard Identification and Risk Assessment – Natural Hazards.*

Natural Hazard National Inventory

- Avalanche
- **Coastal Storm**
- Coastal Erosion
- **Dam Failure**
- **Drought**
- **Earthquake**
- Expansive Soils
- Extreme Heat
- **Flood**
    - **Coastal**
    - **Rainfall Generated**
- Land Subsidence
- Landslide
- **Severe Winter Storm**
- **Heavy Snowfall**
- **Freezing Rain/Icing**
- **Severe Thunderstorm**
- Tsunami
- Volcano
- **Wildfire**
- **Windstorm**
    - **Hurricane**
    - **Tornado**
    - **Severe Thunderstorms**
    - **Frontal Passage**

Many of those hazards can only occur in areas with certain geographic features. To focus mitigation resources to the maximum extent possible, Annapolis eliminated from its planning process:

1. Hazards unlikely to occur within the city
2. Hazards unlikely to cause significant economic damage to the city and its residents.

Those highly unlikely hazardous events are addressed by the Anne Arundel County and State of Maryland planning processes. This document focuses on mitigation plans for damages from natural hazards that might reasonably be expected to impact the City – not necessarily all those hazards that could affect Annapolis.

Through the planning process with County, State and public comment, the city has elected the following natural hazards to assess the damages of and to plan mitigation measures for.

- Extreme heat
- Flash flooding
- Coastal/Tidal flooding
- Hurricane
- Thunderstorm or Tornado
- Winter weather or Nor'-easter
- Fire and Explosion

5.0 Hazard Assessment

To adequately assess the risk of those hazards selected. The previously prepared *Hazard Identification and Risk Assessment for Natural Hazards* was used as the primary reference. That research was conducted recent enough to be considered accurate. The assessment was reviewed and approved by the city government.

5.1 Data Gaps

The most obvious gap in data used to assess the risk to the City of Annapolis, is data collected during and following Hurricane Isabel in September 2003. Because the source document for the assessment was prepared before Isabel, anecdotal information regarding Isabel has been added throughout this document to strengthen the analyses.

The second noticeable data gap in the risk assessment concerns the transitory nature of the Annapolis population. As described in Section 2 above, Annapolis is home to two secondary learning institutions, the state legislature and its support staff, and has a strong tourism industry. Each of these factors puts greater numbers of individuals at risk at different times during the year. All of these considerations are addressed in the mitigation plans described in Section 9 of this document.

5.2 Hazards to the City of Annapolis

Below is selected information from the *Hazard Identification and Risk Assessment for Natural Hazards.* This information was the basis of the valuation of damage from multiple events.

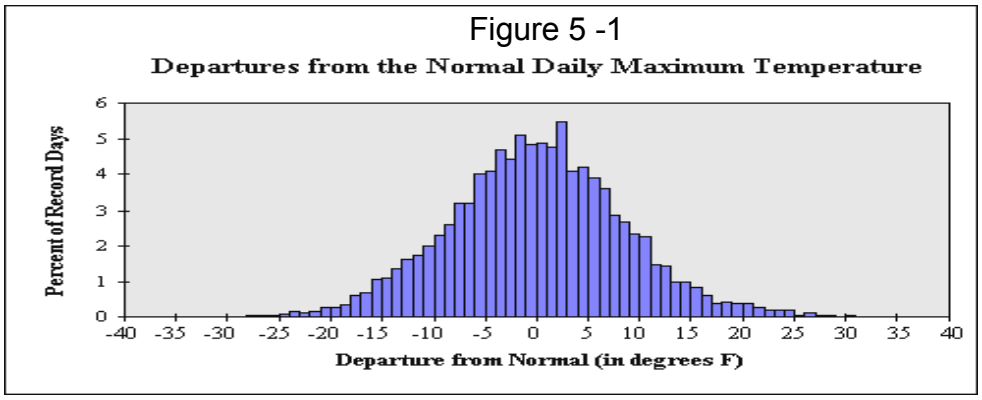
5.2.1 Extreme Heat

Episodes of extreme heat typically are characterized by high temperature and high humidity Extreme heat can cause water shortages, fire hazards, excessive energy demands and damage to infrastructure. When the air temperature is above 90 degrees F and the relative humidity is high, the body is under great stress to maintain its normal temperature. When this situation occurs, heat exhaustion can result, followed by heat stroke.

The climate in Annapolis is considered temperate and rarely do extreme weather impacts cause significant disruption within the City. Annapolis' average monthly temperatures and precipitation are moderate in severity, with average precipitation well distributed throughout the year.

Only approximately 2% of the time does the maximum temperature rise 10 degrees above normal and 1% of the time does the maximum temperature rise 15 degrees above normal. With its temperate climate, these variations rarely cause significant disruption in the City, though prolonged temperatures near 100 degrees during the day with little cooling at night have caused distress among at-risk populations in the City who do not live in air-conditioned housing. Figure 5.1 depicts the frequency distribution of departures from the normal maximum daily temperature. The data used are from the years 1951-1970 and 1976-1997.

Figure 5 -1



5.2.2 Flash Flooding

Flooding is the most common natural disaster nationally. Maryland is subject to two types of flooding associated with rivers and streams. They are flash and riverine. Flash floods occur suddenly with tremendous force, usually as a result of torrential rainfall over a short period of time. The potential for flash flooding increases dramatically if the ground already is saturated from previous rainfall. Flash floods also can occur from a sudden release of water from a dam failure or breakup of an ice jam.

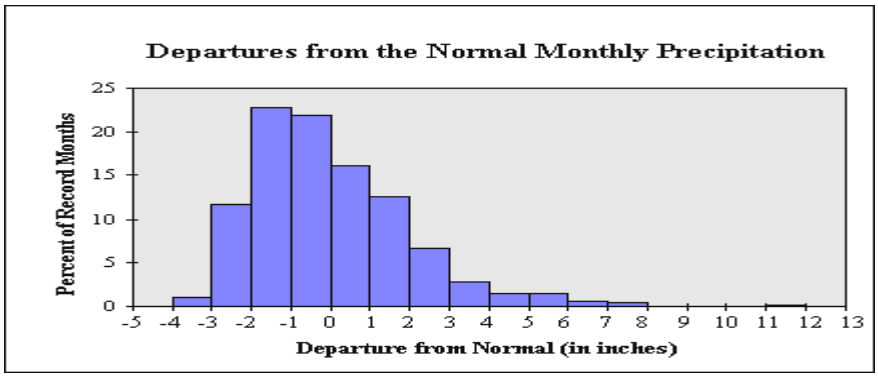
The flooding most often experienced in Annapolis that behaves similarly to flash flooding is also often termed “urban flooding” This flooding can occur when:

- Sanitary sewers are infiltrated by floodwaters causing sanitary sewers to surge. However, Annapolis sanitary and storm-water infrastructures are separate, rather than combined.
- Undersized road and railroad culverts as well as storm water systems can’t convey flood flows
- The capacity of flood control systems (such as drainage ponds) is exceeded
- Wind induced coastal flooding caused storm water drainage systems to back up
- Local ponding
- Lack of maintenance of culverts, storm water and flood control systems, results in unanticipated flooding

While many consider this flooding to be “nuisance” flooding, it no less can cause significant disruption within the City by causing localized flooding that inundates and blocks roads and can cause flooding in buildings in certain circumstances. This nuisance flooding can divert emergency resources from responding to other emergencies, including those resulting from larger-scale flooding along the coast.

One of the greatest rainfall events in recent history was when the remnants of Hurricane Floyd passed near Annapolis on September 15-16, 1999. Recorded rainfall in Annapolis exceeded 11 inches over the two-day period. However, Annapolis' precipitation normally doesn't vary greatly from the norm. On a monthly basis, only about 10% of the time does monthly total rainfall vary 2" from the normal expected rainfall. These variations in rainfall rarely cause disruption in the City. Figure 5-2 depicts the frequency distribution of departures from the normal monthly precipitation. The data used are from the years 1951-1970 and 1976-1997.

Figure 5 - 2



Annapolis experiences significant daily precipitation. However, being a coastal community, little flooding occurs as a result of rainfall.

5.2.3 Coastal/ Tidal Flooding

The National Weather Service defines coastal or tidal flooding as the inundation of land areas along the coast caused by waters over and above normal tidal action that may originate from the ocean front, back bays, sounds or other bodies of water.

Areas of the 100-year floodplain, as mapped by the Federal Emergency Management Agency (FEMA) for Annapolis occur along the Severn River, tidal creeks, and their headwaters. Except for relatively small areas such as the City Dock and portions of Eastport, most developed parts of the City are outside of the identified official 100-year floodplain. The City has in place floodplain management provisions Annapolis City Code (Title 17, Chapter 17.11) that regulate construction within the designated floodplain district. These provisions establish standards for new construction or substantial improvements to existing structures in accordance with FEMA guidelines, in order to prevent excessive damage to buildings and structures from flooding.

The anticipated source of most flooding within the City is the Chesapeake Bay when prolonged on-shore winds cause Bay waters to be driven inland along tributaries and estuaries for sustained

period of time. This flooding can originate from a tropical cyclone, such as a tropical depression, tropical storm, or hurricane; an extra tropical winter cyclone, also known as a Nor'easter; tidal flooding caused by seasonal fluctuations in tides, and other sources such as strong frontal boundaries.

The history of flooding within the City has been generally within those areas identified in the FEMA Flood Insurance Study. Though the current study for the City is over 20 years old, it is presumed to be reasonably accurate but may slightly underestimate current flood potentials within the City. Figure 5-3 is the official flood map panel for the City and Figure 5-4 provides a higher resolution image of the City waterfront and Eastport areas where most flooding is anticipated to occur during a flood event.

Figure 5-3: Flood Insurance Rate Map

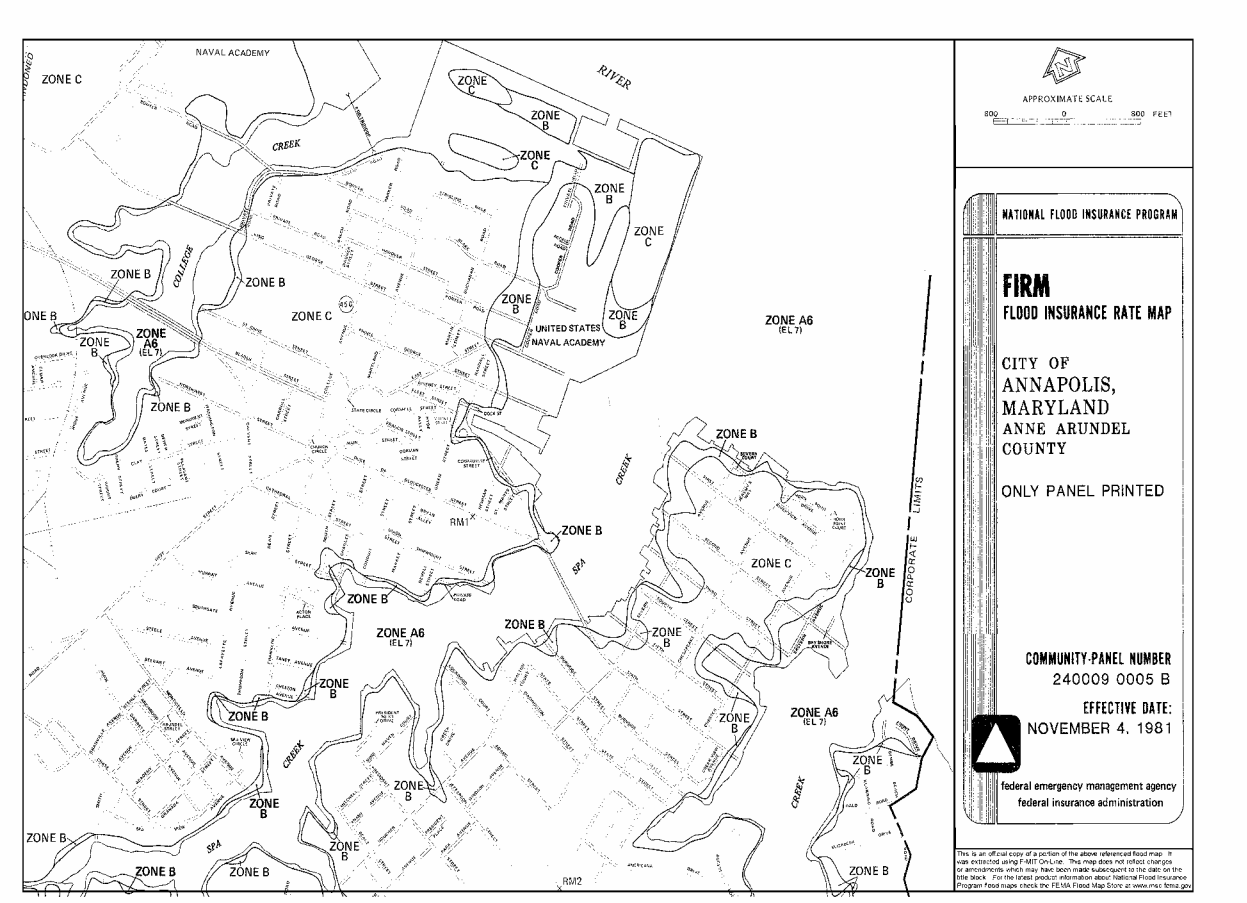
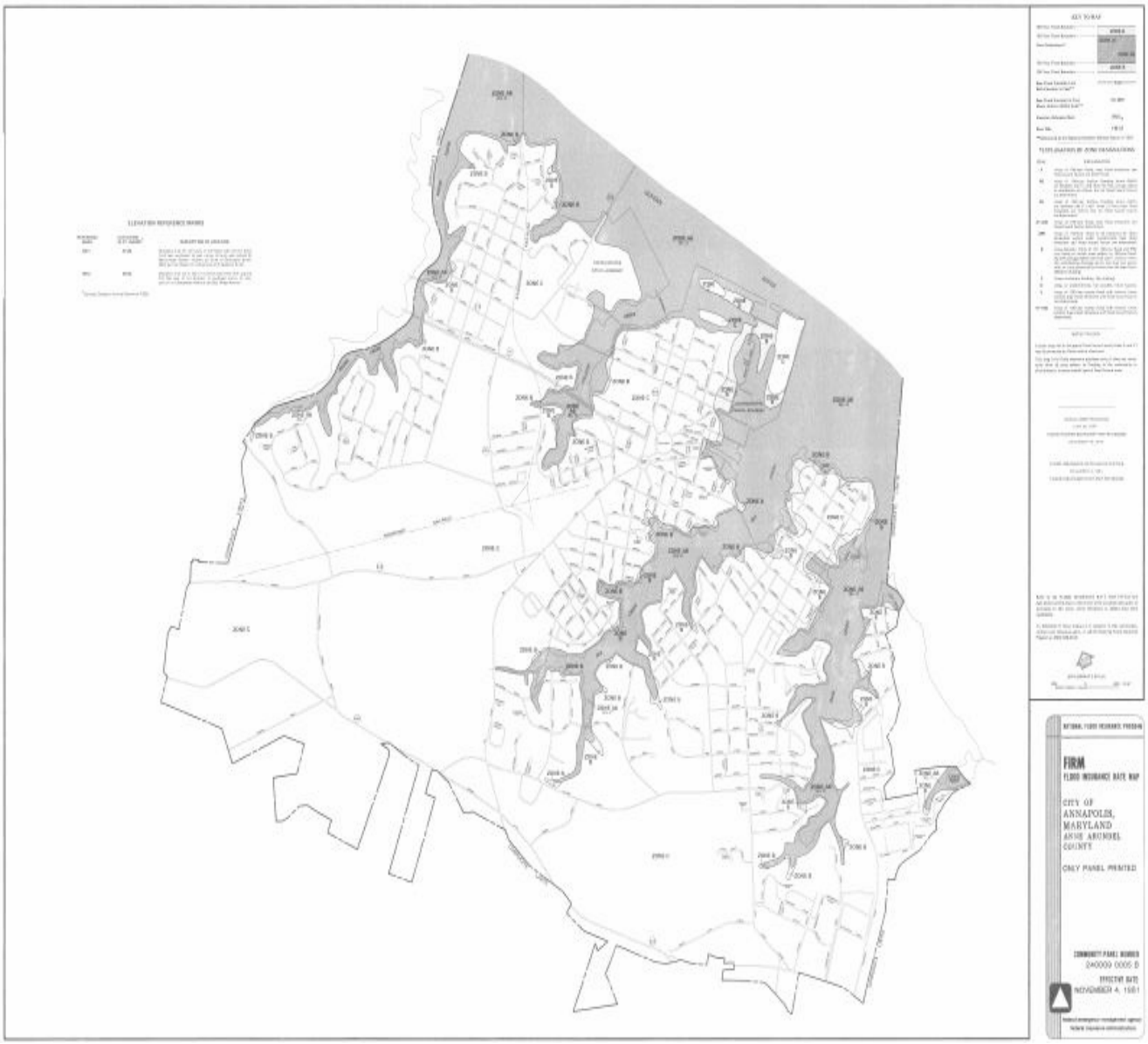


Figure 5-4: Flood Insurance Rate Map of Downtown



5.2.4 Hurricane

Tropical cyclones are among the most powerful and destructive meteorological systems on earth. In addition to very high winds, they are accompanied by a variety of destructive phenomena including heavy rain, lightning, tornadoes, and storm surge. They are identified in three categories – tropical depressions, tropical storms, and hurricanes.

Hurricanes are defined as tropical cyclones with maximum sustained surface wind speed exceeding 74 mph. For coastal areas, the storm surge caused by a hurricane typically is the most dangerous and damaging phenomenon. It is defined as an abnormal local rise in sea level that accompanies a tropical cyclone. The end result is that water is pushed onto a coastline (as described in flooding above). The most notable storm surge in recent Annapolis history was that caused by Hurricane Isabel in September 2003.

Because of its location, hurricanes and their effects are relatively rare in the Chesapeake Bay. On any given year there is an approximately 20% chance of a tropical cyclone (greater than or equal to 39 mph sustained) passing within 75 miles of Annapolis, and only an approximately 3% chance of a hurricane passing within 75 miles of Annapolis.

Tropical cyclones have the potential to pass both to the west and to the east of Annapolis and the Chesapeake Bay. The most dangerous storms for Annapolis are those that pass very close to the west with southeasterly winds that cause storm surges up the Severn River. The majority of storms that affect Annapolis, however, approach from the southwest and pass to the east.

For the purposes of this plan, any tropical cyclone approaching within 180 nautical miles of Annapolis is considered a potential threat. This is because the City would have to respond to such a threat by activating its Emergency Plan.

The tropical cyclone season for the Annapolis area lasts from early June to the beginning of November. The highest rate of occurrence is from the beginning of August to late October. Historically, all hurricanes affecting Annapolis have occurred in this interval. The eighty-seven (87) tropical storms and hurricanes have passed within 180 miles of Annapolis over 115 years (1886-1999). Of the 87 total storms passing Annapolis, 26 were of hurricane strength at their closet point. In some years no tropical cyclones pass within 180 of Annapolis while in other years up to five have passed. Most storms pass Annapolis (near 39°N) after recurvature. The Eastern Shore of Maryland provides enough natural protection, combined with the limited size of the Chesapeake Bay, to prevent the few passing storms from generating high winds or large storm surges in the Annapolis area. Most tropical cyclones affecting the Annapolis area make landfall far to the south on the Atlantic seaboard or pass well to the southeast of the Chesapeake Bay entrance.

The primary approach axis for storms during June-July is overland from the southwest after making landfall in the Gulf of Mexico or along the Atlantic coast. This primary approach axis shifts far to the east during the following months of August-September. Although the majority of

tropical cyclones still make landfall before reaching the Chesapeake Bay, storms tend to travel much farther up the Atlantic coast before encountering land during August-September allowing them to maintain wind intensity.

The most dangerous storms for Annapolis Harbor, Naval Station Annapolis, and the U.S. Naval Academy are those that cause surges up the Severn River and result in flooding. Storm surges in Annapolis are produced when winds from the south retard the Severn River outflow. The effects of a storm are further amplified by heavy rainfall and resulting runoff. Storms passing to the west of Annapolis provide southerly wind fields over the Chesapeake Bay that are necessary to create surges up the Severn River. Flooding of the inner basin of the Annapolis Harbor can occur whenever a storm surge of three feet or greater is experienced at the mouth of the Severn River. In addition, storm surges of three feet or greater cause the Farragut and Dewey seawalls at the U.S. Naval Academy to become questionable moorages.

U.S. Naval Academy Seawall

Annapolis City Dock

Slow moving storms (23 mph) traveling northward would cause the greatest storm surges in the Annapolis area. Faster moving storms (46 mph), although moving in the same direction, have smaller surge effects on Annapolis. Category two tropical storms or greater passing in close proximity to Annapolis have a reasonable chance of causing flooding in the harbor and making the seawalls at the U.S. Naval Academy unusable for moorage.

It has been over 100 years since a hurricane has entered the Chesapeake Bay with an orientation that would bring it near Annapolis, although hurricanes passed within 75 miles of the City in 1954 and 1983. NOAA estimates that such an event would result in a 100-year frequency type of hurricane where wind speeds reach 90-100 mph. While this occurrence is rare, there should be no doubt that such an event would cause significant wind and flood damage within the City of Annapolis that might well severely disrupt the City and take several years to from which to recover. Many historic structures might well be damaged beyond repair, permanently changing the character of the City and causing significant damage to the City's tourism industry.

5.2.5 Thunderstorm or Tornado

Tornado intensity is measured using the Fujita Scale. The intensity of each tornado is determined by the National Weather Service (NWS) through a field investigation conducted by meteorologists.

While Annapolis has not experienced a direct strike from a tornado in recent times, a significant risk from tornadoes exists within the City. Compared with other States, Maryland ranks number 33 for frequency of Tornadoes, 37 for number of deaths, 33 for injuries and 35 for cost of

damages. When we compare these statistics to other States by the frequency per square mile, Maryland ranks number 15 for the frequency of tornadoes, number 30 for fatalities, number 28 for injuries per area and number 27 for costs per area. (Based on data from 1950 – 1995)

From 1950 through 1998, Anne Arundel County was the second most tornado prone County in the State of Maryland. Between 1950-1995, 16 tornadoes struck the Anne Arundel County. The most severe was an F3. Deaths from tornadoes in the County was limited to 3 people during that 45-year period.

Time of day has a strong correlation to the probability of a tornado. While a tornado can occur at anytime of the day, the vast majority of tornadoes strike in the late afternoon and evening. Furthermore, stronger tornadoes tend to occur later in the day. This is why schools are rarely in session when tornadoes occur. It is normally those in after school activities that are often at risk when schools are struck by tornadoes.

In summary, the occurrence of tornadoes in Anne Arundel County can be expected about once every three years with an intensity of probably no more than F2. If occupants of the City take proper shelter during a Tornado Warning, they successfully weather a tornado striking within the City. Tornadoes are some of the most extreme weather events known to occur on earth and the broad generalization that Annapolis has a minimal tornado risk must be taken with some caution.

By contrast, severe thunderstorms can generate torrential rainfall, high winds, frequent lightening, and hail. The National Weather Service uses wind speed and hail size to define "official" severe thunderstorms. A thunderstorm is declared severe by the NWS if wind gusts reach 57.5 mph or stronger or if hail size is three quarters of an inch or bigger. Hailstones are balls of ice that grow as they are held up by thunderstorm updrafts while super cooled water drops hit and freeze onto them. The faster the updraft, the bigger the stones can grow

When updrafts are strong, intense downdrafts, or downbursts, can occur. These downbursts often create gusty winds of nearly 60 mph and on some occasions gusts have been recorded as high as 160 mph. These winds can smash buildings and easily uproot trees and are often mistaken for tornadoes. Large hailstones can cause severe damage to plants and automobiles and also pose a threat to people caught outside in a storm. Heavy rain and flash flooding from severe thunderstorms also pose a serious threat to life and property. Lightning is a very serious threat from any thunderstorm, whether it is severe or not, and officials recommend that people know and obey lightning safety rules when a thunderstorm is near.

Mircobursts are similar to downbursts, but only smaller. A microburst only affects a path of 2.5 miles or less and lasts less than 10 minutes. Downburst can affect a much larger area and for a longer period of time. Often wind damage that's blamed on tornadoes is actually done by winds coming down from a shower or thunderstorm. Such "microburst" winds can reach more than 150 mph.

The Annapolis area has a moderate probability of thunderstorm occurrence when compared to other parts of the U.S. that experience thunderstorms. The Annapolis area can expect approximately 50 thunderstorm events per year.

During the period 1980-1999, Annapolis experienced only one thunderstorm that met the

hailstone size criteria of ¾" in diameter. In addition, Annapolis experienced 5 thunderstorms that produced wind that exceeded the Severe Thunderstorm threshold of 58 MPH.

If one considers 20 years of data as a predictor of severe thunderstorms in Annapolis, it would appear that a severe thunderstorm impacts the City approximately once every 4 years. This equates to moderate risk when compared to other communities located east of the Rocky Mountains.

Finally, weather fronts pass through the Annapolis area throughout the year. While cold front passage in the spring, summer, and fall is often associated with lines of thunderstorms, winter passage of cold fronts is often accompanied by high winds that can occur over a regional area. The high winds are normally predictable and forecast by the National Weather Service by the issuance of either a High Wind Watch or Warning based on the flowing:

A **High Wind Watch** is issued when the following conditions are *possible*:
1) Sustained winds of 40 mph or higher for one hour or more
OR
2) Wind gusts of 58 mph or higher for one hour or more.

A High **Wind Warning** is issued when the following conditions are occurring or imminent:
1) Sustained winds of 40 mph or higher for one hour or more
OR
2) Wind gusts of 58 mph or higher for one hour or more.

Normally, winds associated with frontal passages can result in trees being downed and possibly cause scattered power outages, but rarely do they cause wide-spread sustained disruption within the City of Annapolis. Other impacts can be the banning of high-profile vehicles from the Bay Bridge causing temporary disruption to the flow of traffic over the bridge.

Cold front passage normally results in wind blowing primarily from the Northwest to the Southeast. Since Annapolis is located on the western shore of the Chesapeake Bay, this prevailing wind direction has the beneficial result of not causing Bay waters to back up into the estuaries that dissect the City.

5.2.6 Severe Winter Weather

While the Annapolis area generally experiences relatively mild winters, severe winter weather impacting the city can take the form of heavy snowfall as well as freezing rain/ice storms. The graph (Figure 5-7) below depicts the annual number of occurrences of "winter" days and the total annual snowfall. A winter day is defined as a day with mean daily temperature less than 35 degrees. The red line represents the average amount of snowfall of about 22 inches over the 50 years shown.

Figure 5-5: Annual Number of Winter Days and Total Annual Snowfall at BWI Airport

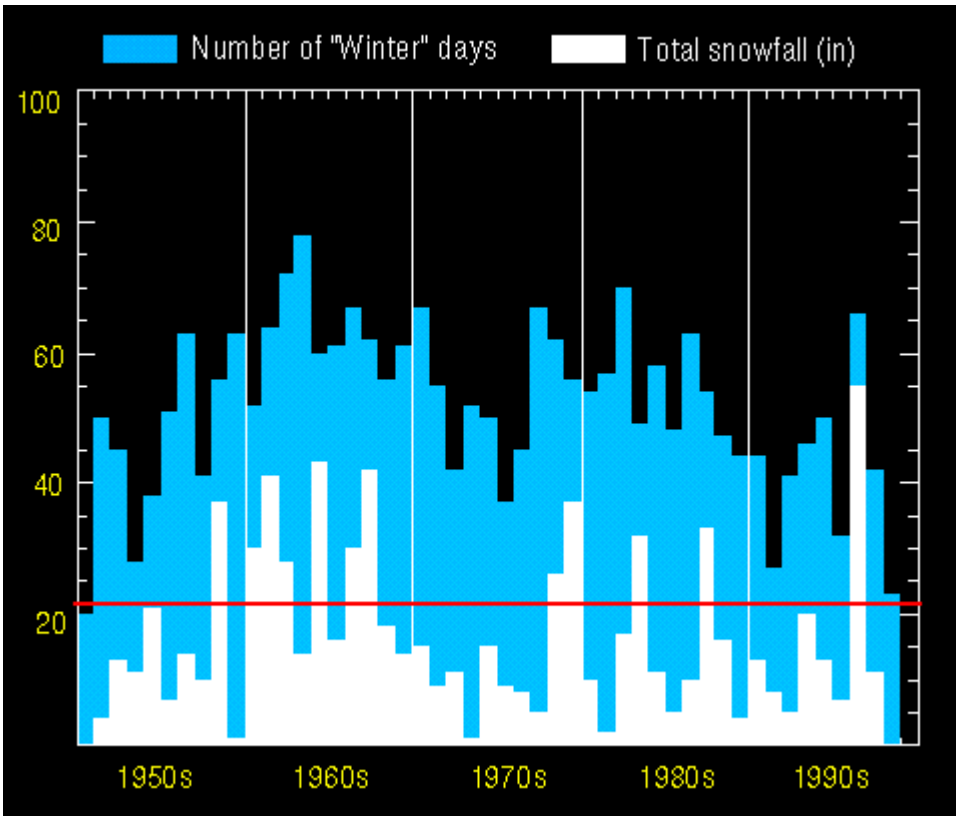


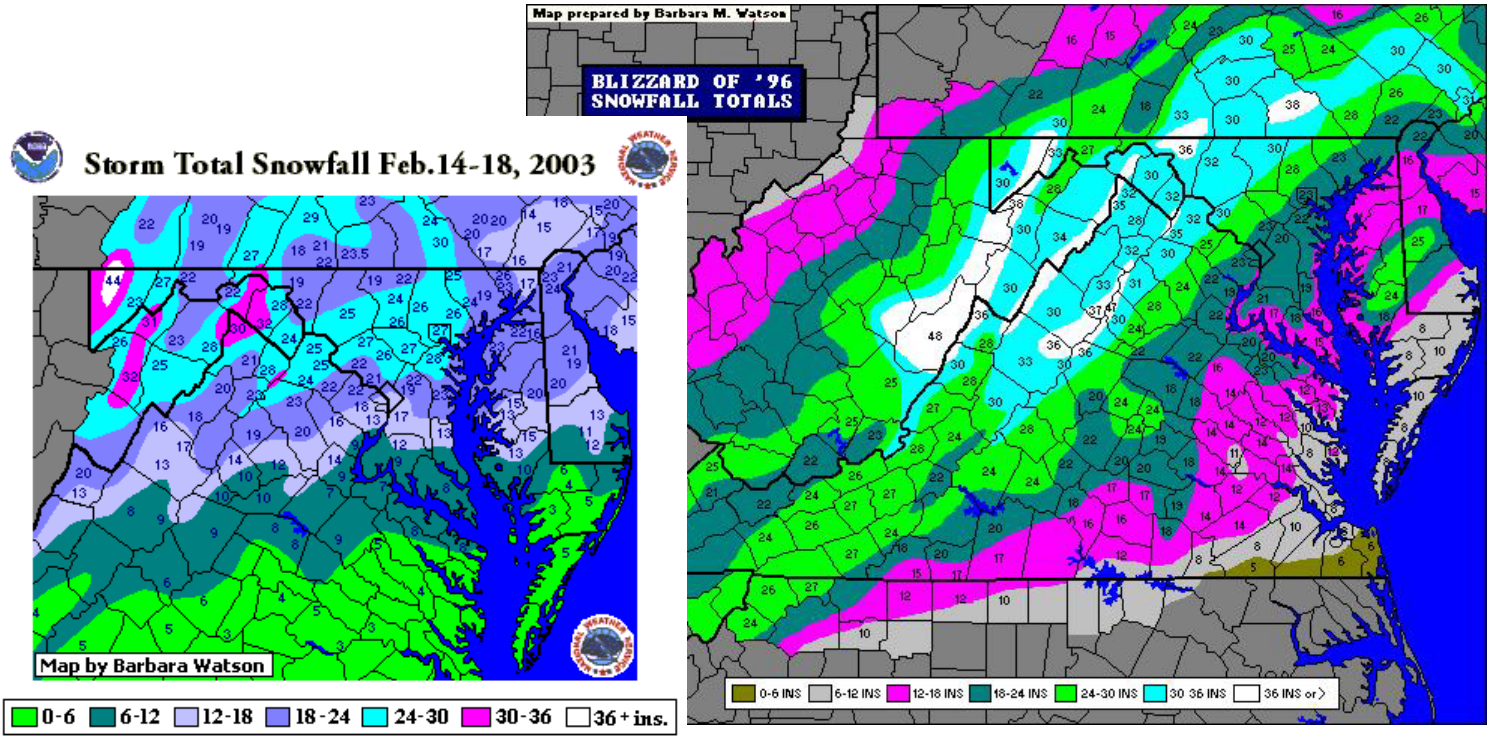
Figure 5-6: Monthly Average Snowfall in Annapolis

November	Trace
December	.6
January	1.7
February	6.6
March	7.6
Seasonal total:	16.5

Based on records kept, Annapolis receives only a moderate snowfall as shown in Figure 5-8. With respect to heavy snowfall, Annapolis' averages are somewhat deceiving in that Annapolis will often go several years with little measurable snow only to be followed by a single heavy or extremely heavy snowfall. As an example, the snowfall during the 2002-2003 winter season set a seasonal total at BWI, Airport of over 55 inches.

The single events that produce the greatest snowfalls in Annapolis are a result of coastal storms that form off the coast of North Carolina or Virginia and track Northeast along the coast. These storms are often referred to as Nor'easters and have resulted in record-setting snowfall. As Figure 5-9 demonstrates, Annapolis can exceed its average annual snowfall from one coastal storm event. In these events, Annapolis received approximately 22 inches of snow from the Blizzard of '96 and the 2003 President's Day Storm showed very similar results, with Annapolis again receiving 23" of snow. In the intervening six years, Annapolis experienced minimal snowfall.

Figure 5-7 Examples of Two Major Snowstorms That Struck Annapolis



Similar to a hurricane, a Nor'-easter is a counter-clock wise turning cyclone (a storm system circulating around a center). Nor'-easter is spawned by a Jet Stream that dips far south allowing cold arctic air to meet warm air. The warm air rises over the cold, creating instability up high and an area of low pressure below. Larger temperature differences create greater turbulence. Once the system is formed, the earth's rotation causes the air to circle around the center. This creates the northeast wind, hence it's name Nor'easter.

Nor'easters typically form near the Bahamas or north of Cuba, along the Appalachians, or off Cape Hatteras. The Jet Stream plays a very important role also in the strengthening of the storm. As the incoming air rises around the center, the Jet Stream whisks it away further increasing the speed of the incoming air. The faster the air moves, the faster the barometric pressure drops. Normal Jet Stream winter pattern is to follow the coast, consequently it drags the storm northeast ward. Some times a High further north blocks its path and so it churns over the ocean for a long time sending large waves onshore. During the October to April Nor'-easter season, February is the busiest month. What Nor'-easters do not achieve in wind-speed (as compared with hurricanes), they achieve in duration (up to a week) and size (up to 1000 miles or more in diameter). Nor'easters can be the cause of significant tidal flooding damage in Annapolis.

Freezing rain/ice storms can also cause significant disruption. Ice coatings can render roadways impassable, cause trees and power lines to snap, and are known to fill emergency rooms with patients with numerous injuries from falls and traffic accidents.

Currently, national climatologies of freezing rain do not exist. In predicting most weather phenomena, climatologies and conceptual models are usually used by forecasters to obtain

general information about the geographic and temporal distributions of, and the mean environmental conditions during, meteorological phenomena. To address this issue, alternative estimates of the risk that freezing rain poses to Annapolis have developed.

According to engineering standards, the 50-yr Mean Recurrence Interval for uniform ice thickness due to freezing rain and the concurrent 3-sec gust wind speed for Annapolis are .5" and 40 mph respectively. Another measure of Annapolis' risk of freezing rain indicates that there were approximately 80 hourly observations of freezing rain at BWI airport over the eight-year period of 1982 to 1990. The level of reported freezing rain averages out to only 10 hours of freezing rain per year.

Freezing rain/ice storms occur when a thermal inversion occurs. A thermal inversion occurs when temperatures are higher above the ground (usually above 1000 feet, but below 10,000 feet) than at the surface. Rain that falls through a shallow layer of freezing temperatures at the surface and freezes upon impact to form a coating of glaze upon the ground and on exposed objects (e.g., trees and power lines).

Data on national percentage of freezing rain to total winter precipitation by month, from 1982-1990 indicates that the greatest threat of freezing rain is during December and the threat gradually recedes through the rest of the winter months. Damages normally occur as freezing rain ice thickness and wind speed increases.

Based on both engineering standards and research, Annapolis does not have a significant history of freezing rains and ice storms and thus has a moderate risk from freezing rain and ice storms.

Annapolis' temperatures do not vary significantly from normal daily highs and lows. As an example, only approximately 2% of the time does the minimum temperature drop 10 degrees below normal and 1% of the time does the minimum temperature drop 15 degrees below normal. With its temperate climate, these variations rarely cause significant disruption in the City.

5.2.7 Fire and Explosion

Maryland's forestlands can be damaged by the threat caused by fires. The main causes of wildfire involve human activities such as: debris burning, arson, equipment use, and children playing with fire.

Wildfire damages woodlands not only by killing trees outright, but also by destroying seeds and seedlings. Fire damages larger trees by leaving wounds, which heal slowly and provide a point of entry for insects and diseases. Wildfire damages not only trees but affects the soil and water quality. Burning off the litter layer exposes the soil to effects of wind and rain. The resulting soil erosion will choke creeks and streams. Fire endangers homes and utilities in wooded settings, causing thousands of dollars in damage each year. A well maintained road system on your property aides in stopping fires by creating a fuel break and by providing a means of quick access of firefighters.

Annapolis has a minimal risk of being threatened by a wildfire, primarily because there is no wild land/urban interface zone. Without wild lands, there is generally insufficient vegetative fuel

available to sustain a wildfire. However, risk from urban fire is great. This risk will be discussed in hazard mitigation plans for man-made hazards. On the average there are approximately 1000 forest fires a year reported in Maryland, Few forest fires rise to the level where they are considered to be wildfires.

6.0 Asset Identification

Little land within the City of Annapolis is undeveloped. Most development within the City is in the form of redevelopment, infill construction, or occurring in areas adjacent to the corporate limits. Except for areas of downtown waterfront and Eastport, most of the floodplain in Annapolis is free of structures.

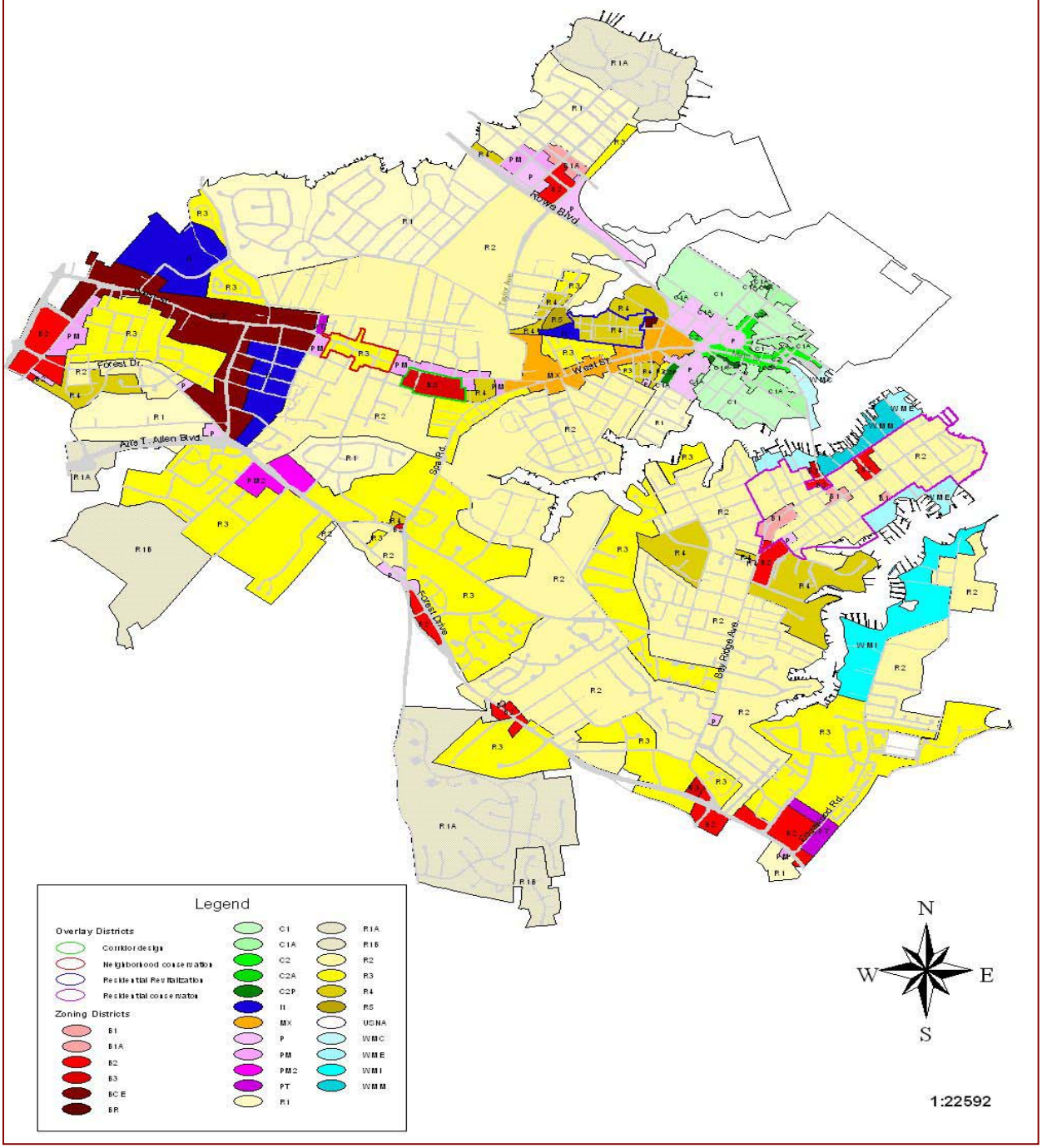
As a Capital City, a considerable amount of the land in Annapolis supports the functions of state government. Technically, the Naval Academy is not within the incorporated limits of the City, yet it is integral with the City as shown on the Zoning Map (Figure 6-1). Any significant hazards located within the Naval Academy would almost definitely have a direct impact on the City or would, at a minimum require the response of the City's emergency response personnel.

The City contains few industrial facilities, though there is a modest maritime industry along the waterfront, primarily on the north shore of Eastport. Primary nonresidential uses include State of Maryland Annapolis offices, Anne Arundel County offices, St. Johns College, retail along main roadways; commercial services for pleasure boating, and hospitality/tourism (hotel and restaurant primarily). These land uses have the benefit of minimizing the locations and amount of potentially dangerous chemicals, biological agents, and nuclear material within the City.

6.1 Process of Asset Identification

Identifying assets of a City such as Annapolis posed a large challenge to the planning group. Consequently, at the recommendation of the State staff, Annapolis has elected to treat all of its neighborhoods as one unified area. The practicality of this becomes apparent in section 7 of this report when damage models demonstrate that aside from the shoreline properties, most of the city will be impacted by a hazard in a similar manner. General mitigation plans will be made for the city as a whole, while specific mitigation plans will be provided for the critical assets described below.

City of Annapolis Zoning



6.2 Critical Assets

In addition to residential and business properties, Annapolis contains critical assets in the form of utilities, public safety, parks, and administrative structures.

6.2.1 Public Utilities

Public utilities serving Annapolis include water, sanitary sewer, storm water drainage, and solid waste. These utilities are managed by the City with the exception of the wasterwater treatment facility, which is a joint responsibility of City and County.

6.2.1.1 Water Service

Annapolis' public water supply is provided by a City-owned and operated treatment plant and distribution system. In addition to Annapolis, the system serves Parole Plaza and some areas next to the City on Annapolis Neck. The U.S. Naval Academy has its own water system while the remainder of the Annapolis Peninsula is served by Anne Arundel County.

Located adjacent to Defense Highway (Maryland Route 450) several miles west of the City, the City's treatment plant handles groundwater extracted from wells. The plant's capacity was upgraded to 10 million gallons per day from 6 million gallons in 1987 and is considered adequate for current and projected future needs. However, various upgrades to the water storage and distribution system are required, some of which are underway, and are included in the City's Capital Improvements Program (CIP).

The Jefferson Place Stand Pipe is the largest in the City, holding 1.75 million gallons.

Annapolis also maintains a water tower on Janwal Street. The City has built another water tower adjacent to the existing tower.

The Navy-Marine Corps Stadium Tank, while located on the grounds of the stadium is the property and part of the City water system.

The Edgewood Rd Tank is located near the intersection to Bembe Beach Rd.

While no longer used to provide drinking water, the City still maintains the Annapolis reservoir and dam. Both are located adjacent to the current water plant, west of Annapolis on MD Route 450.

MDE considers the Annapolis Dam to be a **Significant Hazard** dam since its failure or over-topping would probably result in severe damage to MD Rt 450. Since the Annapolis Reservoir Dam is a high hazard dam, MDE requires the City to develop and maintain an Emergency Action Plan (EAP). The City Department of Public Works is responsible for maintaining the EAP for the

dam. A breach of the dam, during 100 year flood conditions, would result in MD Rt 450 being inundated by floodwater to a depth of 9’.

6.2.1.2 Sanitary Sewer Service

Figure 6-2: Map Showing Location of County/City Sewage Treatment Plant

The City of Annapolis maintains the sanitary sewer collection system, which serves over 98 percent of the City. The Annapolis Wastewater Treatment Plant, located on Edgewood Road next to Back Creek (see Figure 6-2), is jointly owned by the City and County but operated and maintained by the County. On the average, the plant currently treats about 80 percent of its design capacity of 10 million gallons per day. The City uses slightly over 5.4 million gallons per day averaged on a monthly basis (see Figure 6-2 for aerial photograph).

The treatment plant site, located on a peninsula between Back Creek and the Chesapeake Bay, and to the east of Edgewood Road, is outside the 100 year floodplain as identified on the FEMA Flood Insurance Rate Map (FIRM).

6.2.1.3 Storm Water Drainage

Unlike some older American cities, Annapolis' storm water drainage system is separate from the sanitary sewer system. The system generally performs well, with local flooding problems addressed on a case-by-case basis through capital improvement projects. It is maintained by Department of Public Works.

6.2.1.4 Solid Waste

The City's Public Works Department is responsible for solid waste collection. Annapolis currently sends its solid waste to a privately operated disposal site. The 1997 Solid Waste Management Master Plan identifies long-term (20-year) options for Annapolis' solid waste collection and disposal needs.

6.2.1.5 Privately Owned Utilities

Baltimore Gas and Electric operates two electrical substations within Annapolis.

(1) The Cedar Park substation is on Poplar Ave consists of a two-story brick building with adjacent open-air electrical equipment. An 8’ high chain link fence topped with barbed wire surrounds the whole facility;

(2) BG&E also operates a substation in eastern Annapolis off of Tyler Ave. This facility is in a residential area and is surrounded by an 8’chain link fence topped with barbed wire. Figure 3-26 is an aerial view of the station.

6.2.2 Public Safety (Police and Fire)

The 911 system is used for any police, fire or medical emergency requiring the immediate assistance of a Police Officer, Fire Fighter or Paramedic. The Annapolis Police Department has

enhanced 911 capability (E911). When 911 is dialed within the City limits of Annapolis, an Anne Arundel County dispatcher asks if the caller needs Police or Fire/Paramedic assistance. If the caller requests fire/paramedic assistance, the County will dispatch City, County, or both emergency services as necessary. If the caller requests police assistance the call is forwarded to the Annapolis Police Department Communications Center.

6.2.2.1 City Police Department

Annapolis is served by a municipal police force consisting of 124 sworn officers and 30 civilian personnel. The City is divided into seven areas for patrol by car and downtown Annapolis is divided into areas for foot patrol. The main Police Station is located on Taylor Avenue north of the West Street intersection. Because the main station is over capacity, some personnel are housed in a nearby satellite facility. In addition, the department maintains one substation at Eastport Terrace, an Annapolis Housing Authority property. An addition to the Taylor Avenue facility will be constructed in Fiscal Year 2005.

In addition to the City Police, Barracks "J" of the Maryland State Police is located in Annapolis. This Barracks patrol state highways in and near Annapolis and provides security at special events, such as Navy Football games.

Maryland's Natural Resources Police (MNRP), part of the Department of Natural Resources is headquartered in the Tawes State Office Building on Taylor Avenue. In addition, Southern Region Area 3, Broadneck Office, on Prince Georges Street, provides law enforcement for Anne Arundel and Prince George's counties

The Annapolis detachment of the Department of General Services Police has primary responsibility for security on state property within the State Office Center in Annapolis as well as Government House and other historic state-owned buildings within the City, including the State House, the Old Treasury Building and Shaw House.

The Navy Police is a self-contained police department with close cooperational ties with local, state and federal law enforcement agencies in the surrounding area.

6.2.2.2 Fire Department

The Fire Department is served by a municipal fire and rescue force of approximately 98 firefighters and 5 civilian personnel that provide fire and disaster protection, emergency health care, rescue, and related services for the City of Annapolis as well as adjacent parts of Anne Arundel County. The City constructed a new fire station on Taylor Avenue in the late 1980's to replace three former downtown fire stations. The Department currently operates out of three fire stations located on Taylor Avenue, Forest Drive, and Bay Ridge Avenue in Eastport.

6.2.3 Parks and Recreation

The Annapolis Recreation and Parks Department manages the City's parks system. Parkland properties range from active recreational facilities to more passive street ends and nature preserves. The 70-acre Truxtun Park between Hilltop Lane and Spa Creek is Annapolis' largest park, comprising over 50 percent of parkland within the City. Outside of the City, the 500-acre Annapolis Waterworks Park is also owned by the City. A recreation center, The Stanton Center, is located near College Creek.

Development of the City's parks system is guided by the 1987 plan, *Parks and Paths for People*. Many recommendations of that plan have been carried out, while other projects are currently programmed for implementation.

Protection of each of the city's street-end parks is an important responsibility shared by the Recreation and Parks Department as well as Public Works Department. Each street end park is bulkheaded – and protects the integrity of the streets and the utilities buried in the right of way.

Cheston Street End

Third Street End

Taney Street End

Shipwright Street End

In addition to the Recreation and Parks Department, several entities operate and maintain recreational facilities in the City of Annapolis. The Annapolis Housing Authority maintains play equipment and other recreational facilities at its public housing developments. Playgrounds, fields, and other facilities at schools managed by Anne Arundel County Public Schools in and

near the City provide recreational opportunities for Annapolis residents. Quiet Waters County Park, located just south of the City between Forest Drive and the South River, contains 300 acres of open space and waterfront land accessible to Annapolis residents. A number of other recreational providers (the U.S. Naval Academy, private marinas, apartments and subdivisions, etc.) maintain recreational facilities that are not open to the general public.

6.2.4 City Administrative Structures and Public Works Operations Center

The City of Annapolis has several important administrative structures that are critical to its continuing operation. Those include City Hall at 160 Duke of Gloucester Street, Department of Planning and Zoning at 159 Duke of Gloucester Street, and Recreation and Parks offices at 9 St. Mary's Street. The Public Works Operations Center on Spa Road contains equipment that is essential to the continual operation of the water and sewer utilities and other essential services.

6.2.5 Historic Buildings of National Significance

As noted in Section 5, a significant number of historically significant buildings lie in Annapolis. Because these assets are in many instances national treasures, mitigation measures specific to those structures will be developed and implemented in future years.

6.2.6. Education

Public education for the City's school-age population is provided by Anne Arundel County Public Schools. Annapolis and adjacent parts of the County are part of the Annapolis Senior Feeder System, consisting of nine elementary schools, two junior high schools, and one senior high school. Six of the elementary schools and one of the junior highs (Bates Middle School) are located in the City of Annapolis. In addition, the former Adams Park Elementary School near College Creek is used as a Learning Center for children with adjustment problems. None of these schools are located in the 100-year floodplain according to the FIRM.

Each of the public schools in Annapolis has been identified as a critical asset for disaster mitigation because of their significance as a potential shelter area. Also, many of the churches in Annapolis operate a school or have larger meeting space in their property. Those too have been identified as possible shelter areas and so are essential for planning.

6.2.7 Governmental and Institutional Uses

In addition to the City itself, four governmental or institutional entities - the U.S. Naval Academy, State of Maryland, Anne Arundel County, and St. Johns College - are major property owners in or near Annapolis. These institutions contribute greatly to the ambiance and economy of the City. Other important institutional presences in the City include churches and cultural facilities such as Maryland Hall for Creative Arts. The Anne Arundel Medical Center, which previously occupied an approximately five-acre site in the downtown area, has consolidated its facilities at the 50-acre Medical Park site located outside of the City limits on Jennifer Road in Parole.

7.0 – Loss Estimations

Loss projection uses the information generated in the hazard identification to specify locations in which residents of Annapolis could suffer the greatest injury or property damage in the event of a disaster. This assessment identifies the effects of hazard events by estimating the relative exposure of people, buildings, and infrastructure to hazardous conditions. Depending on the data available, a projection could involve counting the number of structures or people in the path of hazards or describing what these hazards can do to physical, social, and economic assets. The loss estimation process helps answer the question, "How will the community's assets be affected by the hazard event?" The most convenient way to express the expected losses is in terms of dollars. These monetary figures are rough estimates

This section provides loss estimations for each of the natural hazards assessed. Refinements to these estimates will be included in future hazard mitigation plans.

7.1 Process for Estimating Losses

In 1997, FEMA, in cooperation with the National Institute of Building Sciences, developed a standardized model for estimating losses caused by earthquakes, known as Hazards U.S. (HAZUS). HAZUS was developed in response to the need for more effective national-, state-, and community-level planning and risk assessment through an enhanced ability to identify areas that face the highest exposure and potential for loss.

HAZUS has now been expanded into a multi-hazard (MH) methodology with new modules for estimating potential losses from wind and flood (riverine and coastal) hazards. FEMA has allocated considerable resources to develop the HAZUS-MH software to quantitatively assess risk, estimate losses from natural hazards, and produce studies that will assist state, local government, community, and private sector representatives to implement programs in emergency response, recovery, and mitigation, including multi-hazard mitigation plans.

FEMA has provided HAZUS-MH assistance to Annapolis to support mitigation planning efforts required by the Disaster Mitigation Act (DMA) of 2000. Loss estimations for the City have been calculated using that assistance.

7.2 Projected Loss Due to Event

According to HAZUS, the geographical size of the Annapolis City region is 7 square miles. There are over 14 thousand households in Annapolis with a total population of 37,480 people (2000 Census Bureau data). There are an estimated 10,871 buildings in Annapolis with a total building replacement value if all were destroyed (excluding contents) of 2,842 million dollars (2002 dollars). Approximately 97.30% of the buildings (and 78.96% of the building value) are associated with residential housing.

There are a number of site-specific characteristics that determine a structure's ability to withstand hazards. Site-specific characteristics that help determine a structure's ability to

withstand hazards and have a direct impact on losses incurred include the following:

- First-Floor Elevations
- Number of Stories
- Construction Type
- Foundation Type
- Age and Condition of Structure
- Use of Structure
- Contents within Structure

Note: Areas and total structures that are vulnerable to various hazards have been calculated based on available City data.

7.2.1 Extreme Heat

As stated in Section 5 above, the climate in Annapolis is considered temperate and rarely do extreme weather impacts cause significant disruption within the City. Consequently, monetary damage potentials were not calculated. However, because of the potential public health threats associated with extended periods of high temperature, mitigation measures in the form of public education on public health threats posed by extreme heat are included in Section 8 of this plan.

7.2.2 Flash Flooding

As described in Section 5 above, Annapolis is subject to little flooding as a result of daily rainfall. This is primarily due to its location as a coastal community. However, so-called urban flooding can cause disruption to traffic and flooding in buildings on certain occasions. Again, mitigation measures in the form of communication plans and public education are included in Section 8 of this document.

7.2.3 Coastal/Tidal Flooding

As described in Section 5 above, coastal flooding is caused by waters over and above normal tidal action. Flood loss estimations for a 100-year frequency flood event have been developed using HAZUS. In Annapolis coastal flooding occurs in conjunction with large rainfall events.

In the event of a 100-year flood event, HAZUS estimates that nearly 2% of the housing stock would be damaged, representing approximately $460 million in loss. ($250,000,000 of which would be contents loss). Figure 7-1 depicts the area likely to be impacted by a 100-year flood event.

Estimates of monetary loss caused by road repairs being necessitated are placed at 116 million dollars. Damages to the wastewater treatment systems are placed at $66 million. Clearly, mitigation plans are needed to minimize such losses should the City be struck by a 100-year flood event

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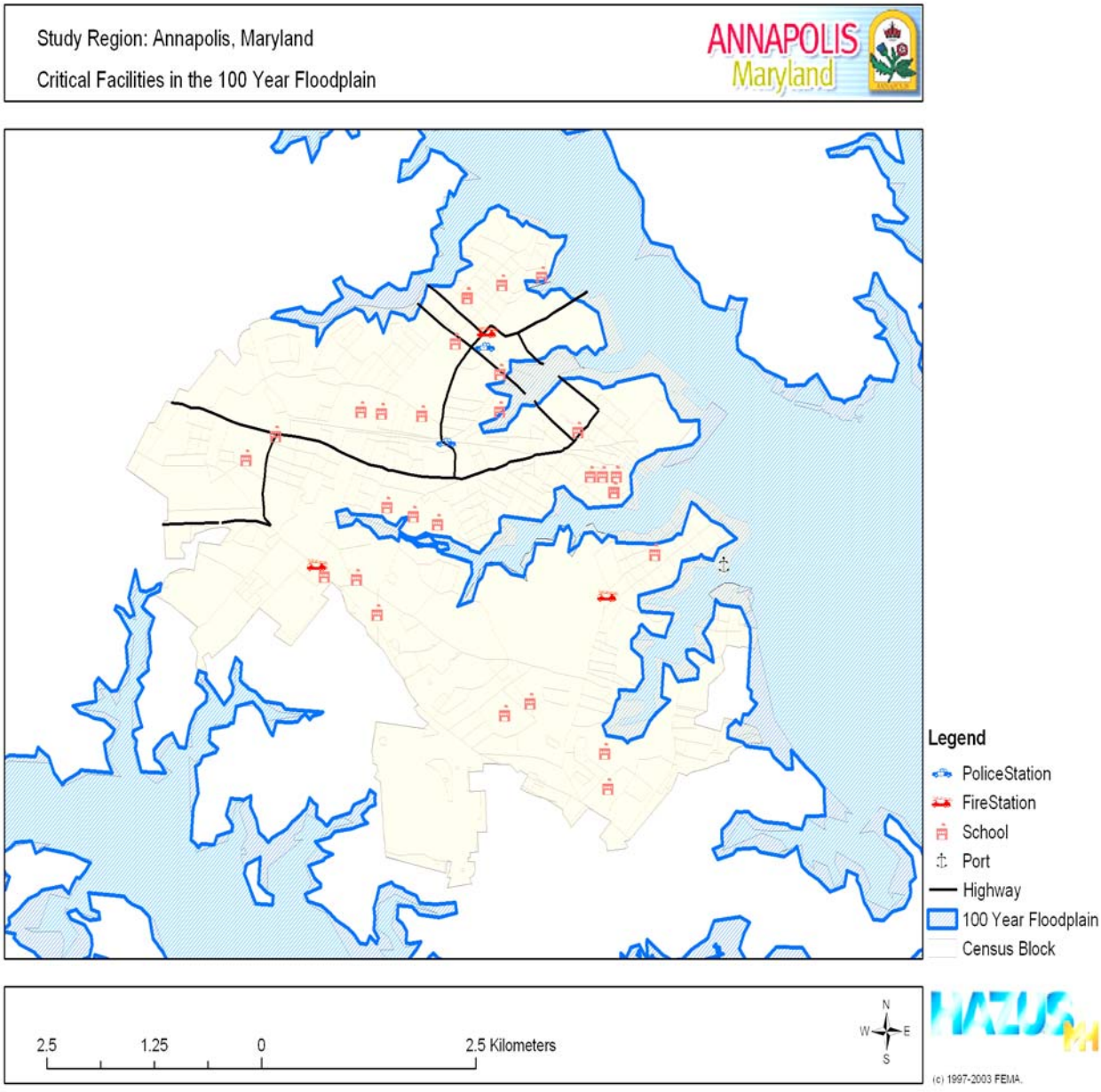

Figure 7-1 100-year Flood Scenario

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Using one HAZUS models Figure 7-1 depicts that Annapolis can anticipate a number of streets to be flooded in Eastport and downtown in a 100 – year event. In addition to residences and

businesses, street-end bulkheads would likely be damaged and possibly City administration buildings

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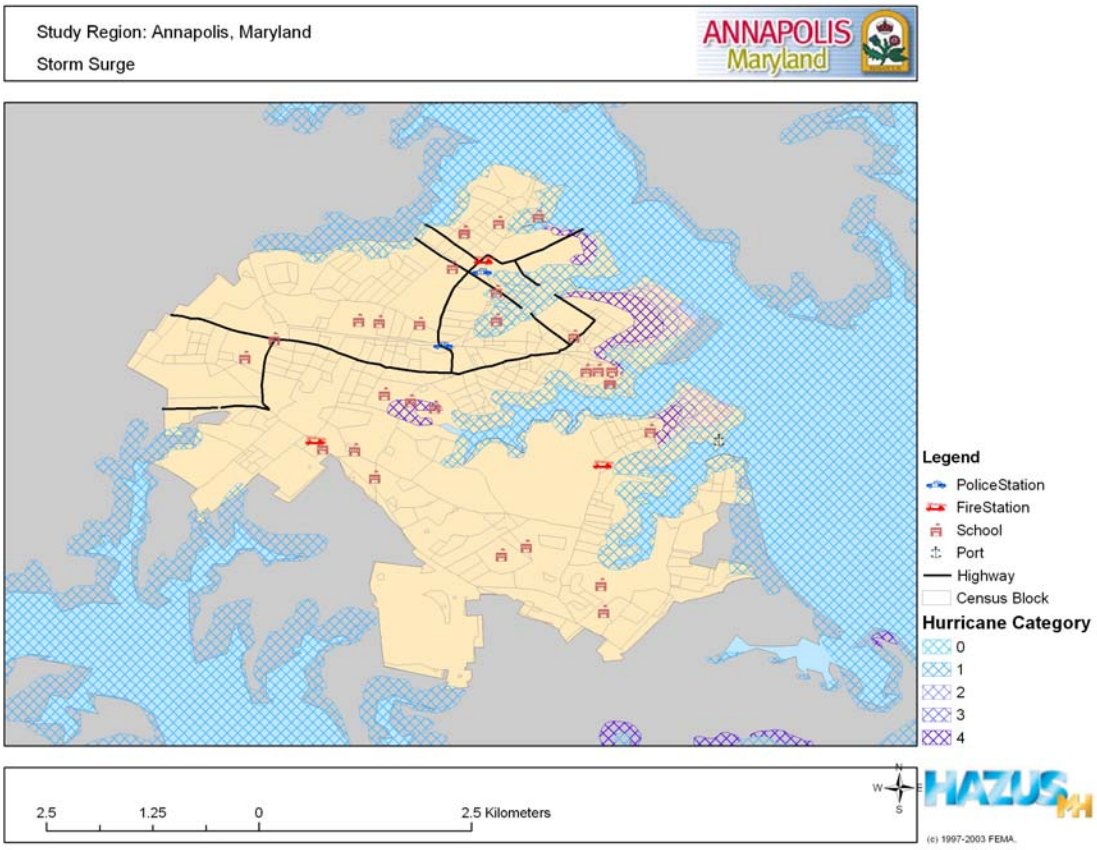

Figure 7-2 Projected Storm Surge Flood Area

In the event the flooding is accompanied by a storm surge (see hurricanes below), a significantly greater amount of damage to City buildings could occur. The photos below and figure 7-2 depict resulting damage from a surge event.

	
Eastport during Hurricane Isabel	City Dock after Hurricane Isabel
	
Approximately 6 foot bank of Old Woman's Cove	Old Woman's Cove during Isabel Surge

7.2.4 Hurricane

As stated in Section 5 of this report, NOAA estimates that a 100-year hurricane event could possibly affect the City of Annapolis. Using HAZUS models, wind-related loss estimations can be developed. Figure 7-3 below depicts the area likely to be affected by wind-related losses from a 100-year hurricane event. There was no wind in Isabel. all damage was caused by the storm surge and subsequent flooding – no debris or waves were pounding.

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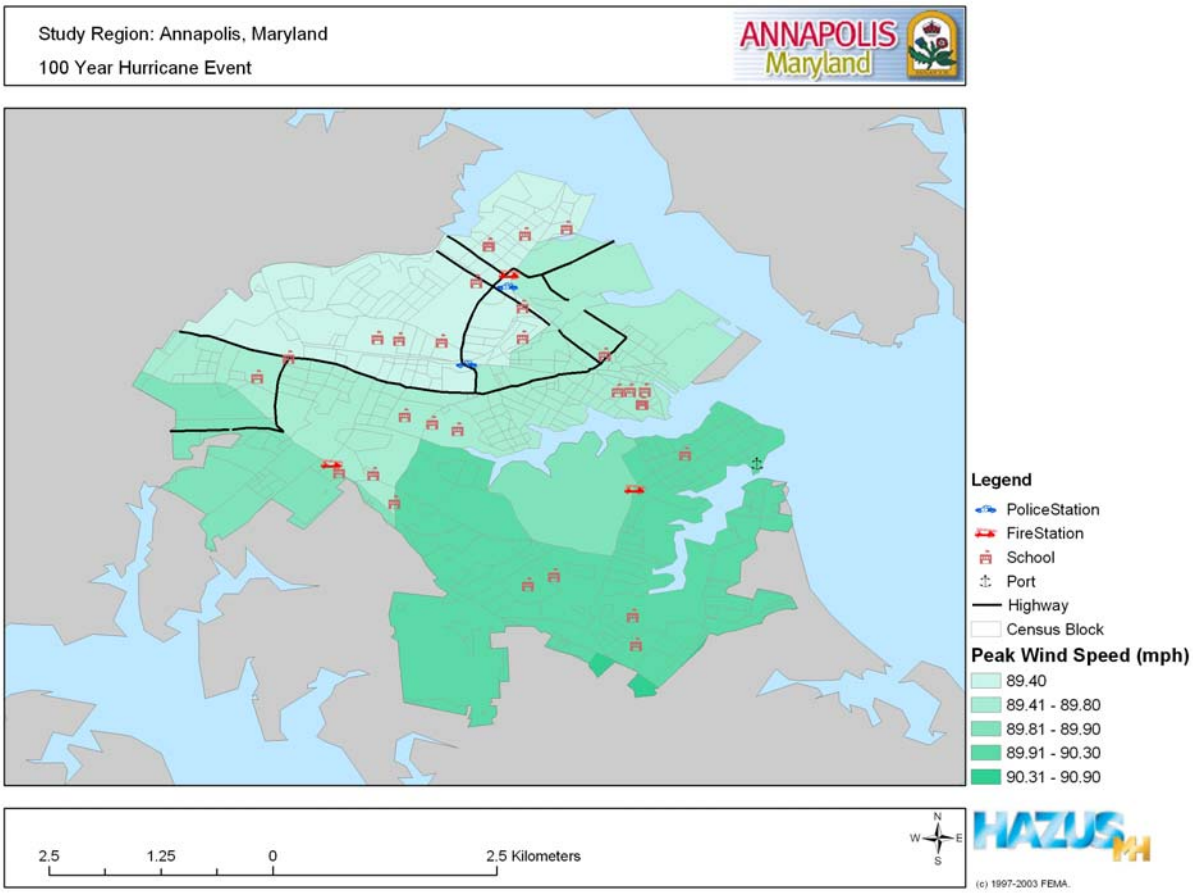

Figure 7-3 100-year Hurricane Event Wind scenario

Debris removal would be a significant expense in such an event. HAZUS models estimate that approximately 28 thousand tons of concrete and tree-related debris would be generated from a 100-year hurricane. HAZUS estimates the monetary loss for building repairs and replacement for such an event at nearly $4 million. Figure 7-4 depicts the building loss estimates from such an event. However, when reviewing Figure 7-4 note that monetary loss areas are attached by the home values. Thus more expensive neighborhoods may appear to suffer greater losses.

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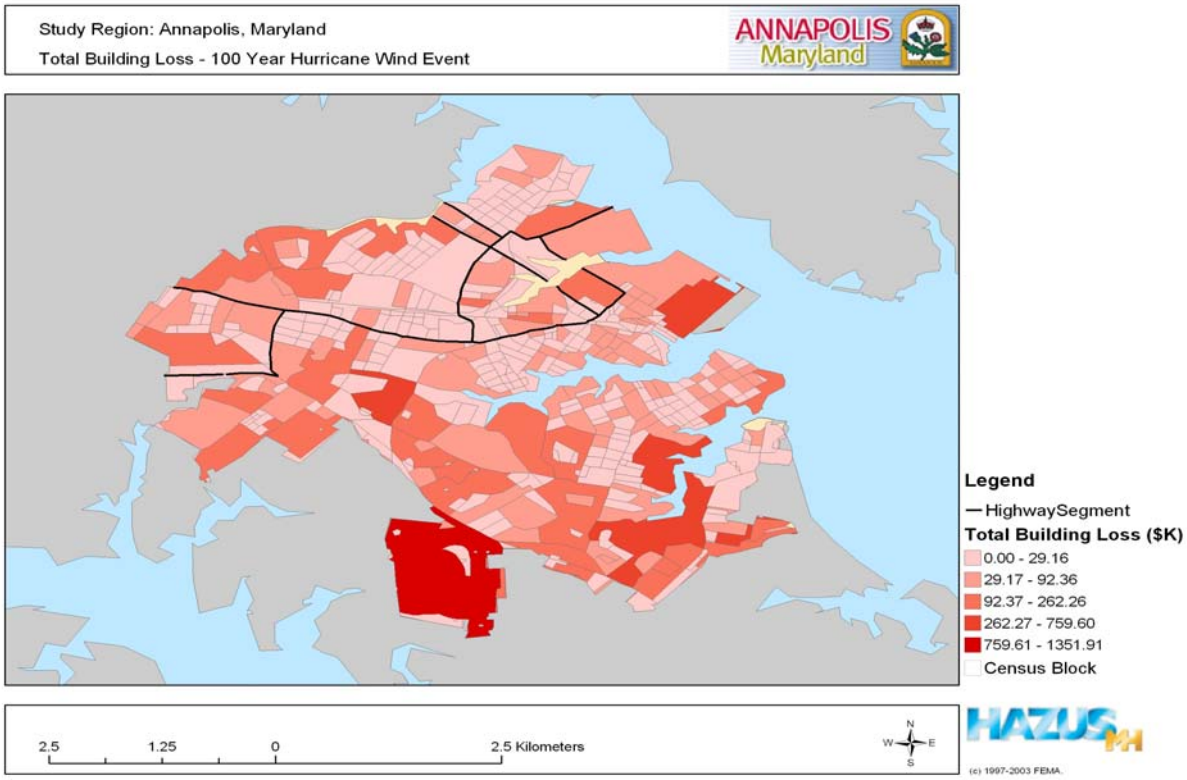

Figure 7-4 100-year Hurricane Building Loss Scenario

Because hurricanes actually cause cumulative damage from flood, wind, surge and debris, it is conceivable that nearly $500 million in damage could result from a 100-year hurricane event. Mitigation plans for controlling such damage are provided in Section 8.

7.2.5 Thunderstorm or Tornado

The impact of tornadoes primarily depends upon their occurrence in developed areas—tornadoes in undeveloped areas may cause damage only to a few trees and may even go unreported. In Annapolis, a large number of structures and people may be subject to tornadoes. Tornadoes, like hurricanes, are accompanied by high winds.

In assessing vulnerability, the most important factor is how likely structures are to fail when they are subjected to wind loads that exceed their design or to flying debris that penetrates the building. In general, building damages can range from cosmetic to complete structural failure, depending on wind speed and location of the building with respect to the tornado path. Structures that are older and in poor condition may not be in a condition to weather high winds and are thus more prone to damage by winds.

Since there are not any standard loss estimation models and tables for tornadoes currently, it is difficult to calculate actual losses. In terms of calculating human losses, shelters throughout the community should be assessed for their locations, capacity, and strength in order to ensure they are able to house residents and withstand the design wind speed. Mitigation plans for tornadoes and other severe storms are provided in Section 8.

7.2.6 Winter Weather

Vulnerability to the effects of winter storms on depends the building codes in effect at the time it was built), the type of construction, and condition of the structure how well it has been maintained.

The entire City would be affected by snow, ice and extreme cold. Severe winter storms could result in the loss of utilities, expected increase in traffic accidents, impassable roads, and lost income since normal commuting may be hindered.

Snow and ice can be extremely hazardous. Can reduce visibility, and when it accumulates on roads, it reduces traction and puts strain on power lines, roofs, and other structures. Severe winter storms have been and will continue to be a significant threat to the economic and social well being of Annapolis. Disruptions of emergency and other essential services and critical facilities are the main threats to the people and property. Inadequate snow removal equipment could exacerbate the effects of snow events, although it is not an issue at the present time.

Severe storm activity poses a significant threat to unprotected or exposed lifeline systems. Generally, commercial power networks are very susceptible to interruption from lightning strikes, high winds, ice conditions, and hail. Other utilities, including underground pipelines, may be impacted if not protected from exposure.

All critical facilities in the City are vulnerable to the effects of severe winter storms, due to the potential disruption of services and transportation systems as well as possible structure failure due to heavy snow loads. Mitigation plans for controlling damage are provided in Section 8.

7.2.7 Fire

In assessing physical vulnerability, the most important factor is the extent to which structures are damaged when they are exposed to fire and heat. Current standard loss estimation tables do not exist for wildfires. However, wildfire related deaths occur as a result of fire suppression activities. If roads are damaged or there is insufficient warning time, other injuries and deaths could occur. Annapolis is not likely to be impacted by wildfire, but mitigation plans are appropriate to address potential urban fires.

8.0 Mitigation Strategy

The Annapolis City Natural Disaster Mitigation Plan is designed to help the city achieve a series of overreaching goals. Those goals are listed below. Each goal is then intended to be achieved through the implementation of the plan elements described below.

- Goal 1.0 – Minimize damage caused by each of the hazards identified for Annapolis:
- Goal 2.0 – Minimize the impacts of hazard events on the residents and businesses located in Annapolis
- Goal 3.0 -- Ensure that existing structures are resistant to damage from these natural hazards
- Goal 4.0 -- Create awareness among residents of the potential hazards associated with these natural hazards and how they can protect themselves and their properties from damaging events.
- Goal 5.0 -- Protect existing community assets in Annapolis from damage caused by these natural hazards.
- Goal 6.0 – Protect the Chesapeake Bay Tributaries surrounding Annapolis to the maximum extent practicable.
- Goal 7.0 -- Ensure hazard mitigation goals are consistent with goals and objectives of other plans in the County and City.

8.1 Process for Developing Mitigation Plans

Mitigation actions are specific actions that help achieve goals and objectives.

Once the goals and objectives were developed and reviewed with public comment, mitigation actions were identified and evaluated address the goals and objectives as they applied to each natural hazard assessed. Specific plans were made by reviewing to documentation provided by the state of Maryland and through review of other jurisdiction's measures. The specific plans were then presented for public comment and review by the resident's of Annapolis, Anne Arundel County officials, and City public officials.

8.2 Mitigation Plans

Although some mitigation plans are specific to individual hazards (such as flooding), many plans are applicable to hazard mitigation, regardless of the hazard – increasing the probability of Annapolis achieving the goals stated above. Below are several of those widely applicable mitigation plans.

Project A: Incorporate hazard mitigation concerns into City planning and budgeting processes

Discussion: By continually revising this plan, City officials will take hazard mitigation planning into consideration as they update and develop comprehensive plans and city budgets.

Project B: Develop a public awareness campaign that will be a long-term initiative providing consistent educational opportunities to advance the community's knowledge and skills. Outreach activities could include the following:

- Displays in public buildings or shopping malls
- Articles and special sections in newspapers
- Radio and TV (public access) news releases and interview shows
- Property protection video for cable TV programs or to loan to organizations
- Presentations at meetings of neighborhood groups, realtors, bankers, or other special interest groups
- Presentations at community association meetings
- Training sessions from related organization such as the American Red Cross
- Website with hyperlinks to other sources of information
- Newspaper inserts, tax and utility bill inserts
- Classroom curriculum on disaster preparedness and safety

Project C: Identify and solicit low/no cost partners to create awareness and promote outreach on hazard mitigation, and preparedness to help business develop contingency plans to minimize losses.

Project D: Create educational materials that are targeted towards the tourist population.

Project E: Promote partnerships between the City and the County to develop a coordinated approach to mitigation activities.

Project F: Work with non-governmental organizations (youth, service, professional, religious) to promote mitigation education and awareness.

Project G: Provide training opportunities for all appropriate city employees.

Project H: Develop a Procedure Plan to include the Mayor, Council, city employees and volunteers to be ready to commit all available resources and coordinate use of city funds, facilities, equipment, and supplies in the event of a disaster recovery effort.

8.2.1. Mitigation Plans Specific to Extreme Heat

Project I: Using tools already developed by other governments in the State of Maryland, customize and distribute brochures and other educational materials on summer weather tips – in both English and Spanish.

8.2.2. Mitigation Plans Specific to Flash Flooding

Project J: Using tools already developed by other governments in the State of Maryland, customize and distribute brochures and other educational materials on flood hazards – in both English and Spanish.

8.2.3. Mitigation Plans Specific to Coastal/Tidal Flooding

Project K: Enhance the business community's awareness and education on flood preparedness and mitigation.

Project L: Conduct environmental education programs to teach people about flooding, the forces that cause it, the factors that cause flood problems, and the significance of protecting the natural and beneficial functions of watersheds and floodplains.

Project M: Promote measures such as site plan review and landscaping requirements to maintain and enhance the preservation of natural features.

Project N: Continue to strengthen open-space programs, particularly street-end buffers in the City limits. Open space preservation should not be limited to floodplains, as some sites in the watershed may be key to controlling runoff that adds to the flood problem.

Project O: Prevent future losses to homeowners by providing residents opportunities to mitigate damages from storm surge to their homes using Hazard Mitigation Grant Program funds.

8.2.4. Mitigation Plans Specific to Hurricanes

Project P: Using tools already developed by other governments in the State of Maryland, customize and distribute brochures and other educational materials on hurricane preparedness, shelter locations and use, boater safety – in both English and Spanish.

Project Q: Offer training programs to residents and property owners on mitigation measures such as window boarding and flood damage prevention.

8.2.5. Mitigation Plans Specific to Thunderstorm or Tornado

Project R: Using tools already developed by other governments in the State of Maryland, customize and distribute brochures and other educational materials on severe weather tips – in both English and Spanish.

8.2.6. Mitigation Plans Specific to Winter Weather

Project S: Ensure residents are forewarned, and prepare City with supplies to face winter storms.

Project T: Stock adequate quantities of salt and sand to expedite road clearing.

Project U: Provide public education (concerning safe driving and driving only if it is required, and also stock up on food, water, batteries, and other supplies) to prepare people for the storm.

Project V: Protect utilities, including underground pipelines, and avoid other disruptions of utilities that may not be impacted and interrupted from exposure to hazards such as hail, icy conditions, high winds, etc.

Project W: Vegetation that lies in close proximity to utilities must be examined and trimmed on a regular basis by BG&E, wherever possible, power lines should be installed underground.

Project X: Increase community awareness and introduce the concept of buffers (pruning back overhanging branches from trees) and windbreaks (planting tall trees to reduce wind velocity or low shrubs to trap snow) to protect against winter storms and winds.

8.3 Summary Table

The table below summarizes each action, assigns it a responsible party, a start date, how each project related to other projects, and each goal satisfied

Action	Responsible Party	Timeframe	Coordination with other Actions	Goal Satisfied
Project A	Public Works	Nov 2004		7.0
Project B	Public Affairs	Nov 2004		4.0, 2.0
Project C	Econ Develop	July 2005		2.0
Project D	Econ Dev.	Jan 2005	Project B	1.0, 2.0, 3.0
Project E	Office of Emergency Management	Nov 2004		7.0
Project F	Community Services	July 2005	Project B & D	4.0, 2.0
Project G	Personnel	July 2005		1.0, 5.0
Project H	Mayor	July 2005		1.0
Project I	Public Affairs	July 2005		4.0, 2.0
Project J	Public Works	July 2005		4.0, 2.0
Project K	Public Works	July 2005	Project D	1.0
Project L	Public Works	July 2005		4.0, 6.0
Project M	Public Works	July 2005		1.0, 2.0, 3.0
Project N	Mayor	July 2005		1.0,2.0,3.0,5.0,6.0
Project O	Plan & Zoning	Jan 2005	Project B	1.0, 2.0
Project P	Office of Emergency Management	Jan 2005	Project B	1.0,2.0, 4.0
Project Q	Neighborhood and Environmental Services	July 2005		1.0,2.0,3.0
Project R	Office of Emergency Management	Jan 2005	Project B	1.0,4.0
Project S	Office of Emergency Management	Jan 2005		1.0,4.0
Project T	Public Works	Jan 2005		1.0
Project U	Public Affairs	Jan 2006	Project B	1.0,2.0,4.0
Project V	Public Works	July 2005		1.0,5.0
Project W	Public Works -- BGE	July 2005		1.0,5.0
Project X	Public Works	July 2005	Project B	1.0,2.0,4.0,5.0

9.0 Plan Maintenance

This Plan is the City of Annapolis' road map for

- Evaluating hazards
- Identifying resources and capabilities
- Selecting appropriate actions
- Developing and implementing mitigation measures to eliminate or reduce future damage from those hazards in order to protect the health, safety, and welfare of the residents in the community

This plan also identifies procedures for keeping the plan current and updating it at least once every five years, as prescribed by the Disaster Mitigation Act of 2000.

9.1 Monitoring, Evaluating and Updating the Plan

Monitoring, evaluating, and updating the Plan are critical to maintaining its relevance. Effective implementation of mitigation activities paves the way for continued momentum in the planning process. It also gives direction for the future.

A permanent entity needs to be responsible for maintaining the Plan and for monitoring, evaluating, and updating it. Office of Emergency Management will oversee the progress made on the implementation of the identified action items and update the Plan, as needed, to reflect changing conditions.

Evaluation of the plan should include not only checking on whether or not mitigation actions are implemented, but also assessing their degree of effectiveness. This would be done through a review of the qualitative and quantitative benefits (or avoided losses) of the mitigation activities. These would then be compared to the goals and objectives that the Plan was intended to achieve. Office of Emergency Management would also evaluate mitigation actions to see if they need to be modified or discontinued in light of new developments.

The Plan will be updated every five years, as required by the DMA 2000, or following a disaster. The Plan will be updated by Office of Emergency Management. The updated Plan will account for any new developments in the City or special circumstances (post-disaster). Issues that come up during monitoring and evaluation, which require changes in mitigation strategies and actions will be incorporated in the Plan at this stage

9.2 Public Involvement

Office of Emergency Management will involve the public during the evaluation and update of the Plan through annual public education activities, public workshops, and public hearings. A public meeting will be held to obtain public input for plan evaluation. The public will be notified

through a newspaper advertisement. The City's website will serve as a means of communication by providing information about mitigation initiatives.

9.3 Updating the Plan

Throughout the hazard analysis and vulnerability assessment, descriptions of missing or inadequate data indicate some areas in which the City could improve its ability to identify vulnerable structures. As the City works to increase its overall technical capacity and implement their comprehensive planning goals, it will also attempt to improve their ability to identify assets vulnerable to hazards.